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ABSTRACT

This paper describes a prototype software tool for support of peer-to-peer conversation in distance education courses in text-based asynchronous mode, utilizing the visual structure of multiple threads of conversation. The theoretical basis for this design is a comparative analysis of oral, written, and electronic communication that enables the identification of properties of the conversation structure relevant to software design--fragment length and fragment linking mode. Combination of these properties gives rise to linear or multithreaded conversation structures. Topics discussed include: (1) conversation, including conversation structure and linearity, conversation fragment linking, and stylistic aspects of oral, written, and electronic conversation; (2) existing systems that support text-based conversation, including e-mail and conferences, the Coordinator tool, hypertext systems, and electronic whiteboards; (3) the prototype, including its main properties and implementation; and (4) conclusions and future research plans. A table contains a comparison of oral, electronic, and written media. Two figures illustrate an e-mail transcript and conversation threads represented spatially. (Contains 25 references.) (Author/DLS)

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Visual Support of Multithreaded Conversation for Collaborative Learning

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Abstract: This paper describes a prototype software tool for support of peer-to-peer conversation on distance education courses in text-based asynchronous mode. This goal is accomplished by visualizing multiple threads of conversation. The theoretical basis for this design is a comparative analysis of oral, written and electronic communication which enables the identification of properties of the conversation structure relevant to software design: fragment length and fragment linking mode. Combination of these properties gives rise to linear or multithreaded conversation structures.

1. Introduction

Asynchronous text-based communication, having been available since the earliest days of the Internet, continues to play an important role in almost all electronic communities and, in spite of the development of new multimedia technologies enabling sound and video communication, seems likely to persist for some time. This medium possesses some traits that are very useful for educational purposes. Experience of distance educators shows that this medium is best suited for group discussions and seminar-type studies, rather than for delivery of basic lecture material [Hiltz 1992], [Harasim 1990], [Garrison 1993]. Students interact with each other and with the instructor, discussing, debating and elaborating their growing knowledge.

In a traditional setting interaction between students takes place largely through natural language. It implies intensive message exchange and conversations between participants. [Kaye 1992] stresses the importance of social and linguistic aspects of communication: its active character. Knowledge results from active interaction between students and instructor, or even only among students, as opposed to the understanding of learning as knowledge acquisition from some external source.

Introduction of a new medium changes the structure and character of communication, and these changes can be for better or for worse [Adrianson & Hjelmquist 1991], [Fulk at al. 1992], [Kiesler et al. 1985], [Er & Ng 1995], [Dubrovsky et al. 1991], [Grote & Baitsh 1991]. It has been found that users evaluate a medium largely on the basis of its ability to support different types of conversation [Lea 1991], [O'Connail et al. 1993], [Kraut et al. 1992]. Problems in conversation caused by the introduction of a new medium may drastically decrease the quality of learning, so our ultimate aim in the research is to provide software that provides beneficial support for users' conversational activities.

2. Conversation

Having chosen a conversation as an object of the inquiry, we have to work out an approach we will take for analysing it. Conversation is a subject of many disciplines: philosophy, psychology, linguistics, media studies, etc. Each possesses a particular approach, aim and methodology, often incompatible and incomparable to other

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disciplines. So it should be explicitly stated how we define the object of the research, and how we observe, measure and evaluate it.

2.1 Conversation Structure

In this work a surface structure of conversation as an indicator of communication processes was chosen. There are several advantages of dealing with conversation structure only. First, it is very easy to observe, since in text conditions transcripts are generated automatically. It is also easier to conjure the problems encountered by users from conversation breakdowns. Application of this method can give new data when analysing conversation [Seller 1995].

2.2 Oral, Written and Electronic Conversation

To gain an insight into the structural aspects of conversation, three forms of verbal communication are compared: oral conversation, writing and conversations that take place in email and computer conferencing. Writing (or, to be more specific, printed text) here is also considered as a form of silent conversation of an author with a reader, or with herself. With most media: writing, TV, special codes, etc. we ultimately end up with messages in the some language. So here the term 'conversation' will be used in a broad sense to denote any activity in natural language taking place between interlocutors.

2.2.1 Linearity

Written and oral communication were compared along the linear vs. non-linear lines [McLuhan 1964]. The first was considered linear, the second – non-linear, simultaneous.

It is easily understood that writing (print) is a linear medium. In a book, word is followed by word, sentence by sentence, chapter by chapter, etc. Writing something down allows conceptualisation of the sentence as a spatial object with a linear structure [Lakoff & Johnson 1980].

But oral conversation is to a large extent linear too. Words are pronounced in a linear order, one after another, at one moment only one interlocutor can talk. Consider, for example, a 'conversation is a thread' metaphor existing in the language: *lost the thread (chain, connection) of his argument; resume or take up the thread of; gather up the threads.*

2.2.2 Conversation Fragment Linking

The difference between oral and written conversation structures is in the way the 'links' are connected. Due to the ephemeral nature of speech, interlocutors can only refer to something said relatively recently. Topics are changed often; there exist many incomplete, abbreviated sentences. This creates a linear structure with short links.

The persistent nature of text, on the other hand, allows people to refer accurately to something created a long time before. Something can be referred several pages back or forward and looked up when necessary. This in theory allows the building of complex non-linear structures. But the tradition of print downplayed this trait of text. The attempts to break this linearity (e.g. footnotes, cross-references) were marginal (in both the literal and metaphoric sense).

New electronic media inherit the persistent nature of text, but are less hindered by printing tradition. The recent explosive growth of popularity of hypertext shows the huge potential of non-linear structures.

Text-based asynchronous communication allows the weaving of complex webs of argument, where in the same 'conversation space' several topics can exist simultaneously. One outcome of this new trait is the multithreaded structures of on-line discussion. Over 80% of messages in computer conferences reference one another [Harasim 1989]; also one message may contain more than one topic [Riedl 1989]. How this new trait can be used for computer tools design will be described later in this paper.

2.2.3 Stylistic Aspects

[McLuhan 1964] stressed the importance of visual versus audio sensory channels in media evaluation, the opposition of ear and eye and consequent differences in style and usage.

Text-based electronic conversation is visible, like text. It is essentially a written form of communication and is usually approached as such. But it has been suggested that electronic media in some aspects are similar to oral communication [Ong 1982], [Bolter 1991]: spontaneity, rapid exchange of messages providing almost immediate feedback, and fluid structure of information are all traits indicative of an oral style. From oral conversation it also borrows the way of referencing other pieces of text. When quoting parts of others' messages in their own, people refer to them as to something said rather than written.

	Exchange rate	*Message Lifetime*	*Linearity*	*Link length*	*Sensory channel*
Oral	Fast	Short	Linear	Short	Audio
Electronic	Fast	Short or long	Non-linear	Short	Visual
Written	Slow	Long	Linear	Long	Visual

Table 1: Media comparison

[Tab. 1] provides an illustration rather than the precise taxonomy of medium traits. Electronic medium is a very broad term and allows for a wide range of values for any of the traits. Messages can be kept long time or erased immediately. Message exchange speed can vary from almost synchronous, to delays of days, weeks and months. The purpose for including this table is to emphasise the point that electronic medium allows for a special kind of communication that shares some properties with both oral and written communication, being nonetheless unique. That is why it is impossible to directly apply existing theories for oral and text communication to its analysis.

3. Existing Systems

This section will review existing systems that support text-based conversation. It is important to remember that a communication system is always situated in a social context. When users exploit the system, they augment and modify its technical properties with social procedures. This is especially true for conversation, which is very flexible. Conversation patterns change depending on particular media and contexts [Ackerman et. al. 1997]. It seems that users feel that for a particular medium a particular style of communication should be used, so when they had to send their messages with another medium, they often wanted to recompose their messages [Whittaker et al. 1997]. Being aware of this process, we will pay attention to both the technology itself and its usage, because the usage can give us insights into the real needs of users.

3.1 Email and Conferences

Email systems disrupt conversation by putting incoming and outgoing messages into inbox and sent items folders. It is equivalent to taking a dialogue from a book and sorting all the utterances by the interlocutors. The information remains the same, but it is not a dialogue anymore. So users have to rely on their memory and imagination to reconstruct the conversation as it really is. To bypass this restriction, users found a way to transmit a conversation context by quoting the original message in the reply. [Fig. 1] shows an example.

Original message:
I propose to invite Jane on Friday. She will be able to have a good weekend's rest before starting her work.
The University will benefit from her contributions.
Reply:
>I propose to invite Jane on Friday.
I have only been able to make a reservation since Saturday, but I guess it's still OK.
>The University will benefit from her contributions.
I agree completely. We just have to make sure her lectures fit nicely into our overall programme.

Figure 1: Email transcript

The lines marked with '>' in the reply are quotations from the original message. In this fragment we can notice the informal style of the message, similar to oral exchange. Two threads of conversation can be easily identified, but they are 'crammed' into one linear mail message.

Some conferencing systems do provide the threading facility, allowing people to post replies to existing messages, creating thus tree-like multithreaded structures. Among such systems are Lotus Notes™, Collabra included into Netscape Communicator™, and other commercial software. All messages are put into one folder, so conversation is traced easier. Still, such systems design is centred on the message exchange metaphor, e.g. comments are possible to the whole messages only. Very often people also quote the original message in their reply, like in email systems. This reflects the need for finer granularity of a reference unit.

3.2 Coordinator™

A notable attempt was undertaken by Winograd and Flores [Winograd & Flores 1986]. Drawing on Speech Acts theory they developed a tool called Coordinator™. Conversation was conceptualised as a set of building blocks representing particular speech acts that were followed one by another. Users could construct conversation from these blocks. The main drawback in the Coordinator's design was that the authors drew on *Speech* Acts theory, but, as was shown above, conversation is different in electronic medium. At any one moment the conversation supported by the Coordinator could only be in one state, not accounting for the multithreaded structure of on-line conversation.

3.3 Hypertext Systems

Usually hypertext systems lay stress on the written nature of interaction. With them people *write* hypertext. Even group systems are conceptualised as a collaborative writing systems, rather than communication systems.

Only some of them support spatial representation, e.g. Aquanet and VIKI [Marshall et al. 1994]. These are hypertext-based tools that exploit free spatial layout to support the task of information structuring. As such, they are aimed at a different mode of structuring 'conversation' than the current work. However their work is a good source of evidence of the power of spatial organisation of text, and the consequent interface and usability challenges.

3.4 Electronic Whiteboards

There exist a number of 'whiteboard' tools supporting a shared drawing space. For example, NetMeeting [Microsoft, 1998] is a suite of conferencing tools supporting synchronous multimedia communication between users connected over any kind of computer network, including the Internet. One of the NetMeeting tools is the Whiteboard, which provides a drawing space on which participants can type text and draw lines and other shapes. Whiteboards do not usually have any clear data model underlying the whiteboard display and the focus is on synchronous communication. There exists a subclass - Conversational Props Software. Its main idea is that people would often use some artefacts as conversation props and build their conversation around them [Hill et al. 1994]. Usually such systems are complex multimedia ones. They support several communication channels. For example, on video there can be transmitted an image of some artefact or drawing, and conversation would be in audio mode. The emphasis in such software is more towards the support for different media types, rather than richer support for text communication itself, and so this software is not considered further in the current work.

3.5 Conclusions

The main area where the potential of electronic media is not adequately realised is its ability to support non-linear, multithreaded conversations. Existing software tools do not support effective creation, presentation and navigation of such structure. Some are too restrictive (email, conferences) others (whiteboards) have almost no underlying data model. There is a need to design a data structure that is flexible "in the right direction" and firm enough in others *to support* conversational activities. All this leads to formulating prototype specifications.

4. The Prototype

In the current research an attempt is made to support a specific property of electronic communication, namely multithreadedness, at the same time preserving the informal, spontaneous style of oral conversation and enhancing the support for the visual nature that it shares with text. This is accomplished by visualising threads and message references spatially.

To illustrate the main idea, let us return to the excerpt of an email message [Fig. 1]. The most obvious improvement is to allow users to comment on items and arrange them spatially [Fig. 2].

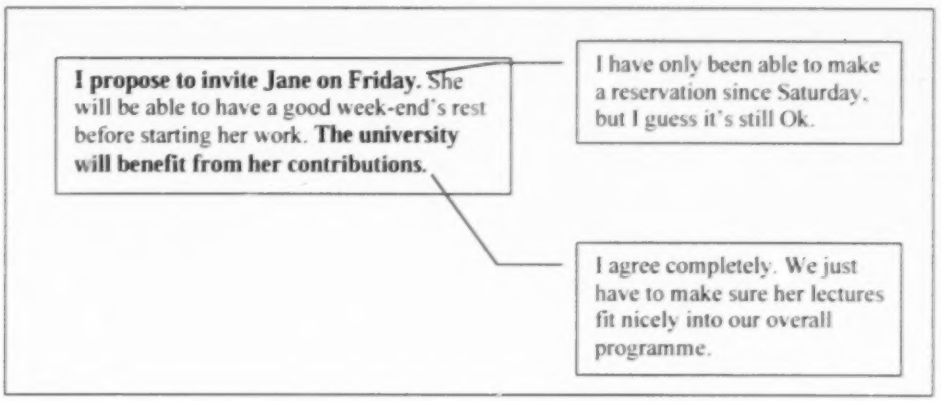
I propose to invite Jane on Friday. She will be able to have a good week-end's rest before starting her work. **The university will benefit from her contributions.**
I have only been able to make a reservation since Saturday, but I guess it's still Ok.
I agree completely. We just have to make sure her lectures fit nicely into our overall programme.

Figure 2. Threads represented spatially

This will allow the construction and presentation of complex hypertext-like structures. Here we will make use of the fast oral way of the connecting remarks. At the same time the textual and visible nature of the communication brings the potential for deeper reflection and continuation of such conversation over longer periods of time. Here are the main properties of the prototype:

- spatial presentation of conversation threads
- granularity of reference unit – any continuous part of text
- oral way of connecting remarks

4.1 Implementation

The most promising platform for the delivery of distance education courses is WWW, so the one technical requirement is that the prototype is integrated into it. So we are implementing it in Java with a client-server architecture. The client is implemented as a Java applet. The server is a Java application that performs queries and stores info in a relational database. Currently, since the system is designed as asynchronous, only one user can be active in a space at any one time. This makes it much simpler from the engineering viewpoint, but enables the basic visual design options to be explored.

Given the limitations on space, here we concentrate on the theoretical aspects of the work. More technical details on the system implementation are available from authors.

5. Conclusions and Further Research

The research showed the possibility of creating software on the basis of conversation surface structure. Further research will concentrate on gathering evaluation data from user trials with the prototype. This will give rise to the second iteration of the prototype, and its evaluation in a more realistic setting. Generally, besides the methodological aspects this research raises major HCI challenges. Supporting speech interaction in such a complex cognitive activity as learning, using a highly spatial style, will require exploration of the need for

optimizing the display, using scaling and perhaps text colouring and shading, and enabling multiple configurable views of the conversation "graph". All of this would need to be done in such a way as to provide a smooth and more or less "transparent" interaction style, to minimize inhibition of the free, spontaneous nature of such conversations.

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